Driven motion of the third phase on the oil | water interface by three-phase boundary reactions

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A highly competitive system is the reaction at the three-phase boundary at which the electrode was exposed to both the oil and the water phase, explored by Scholz and coworkers[1-3]. It is composed of an oil droplet mounted on the electrode in an aqueous solution. A typical cell apparatus is composed of the oil droplet including only a redox species, which is located on an electrode in an aqueous solution including supporting electrolyte[4-7], as is shown in Fig.1A. An air bubble mounted on an oil | water interface is a probe not only of interfacial tension but also of properties of three-phase boundary reactions[8].

This report is devoted to investigating the static and dynamic behavior of the air bubble on the O|W interface in the context of the three-phase boundary reaction of ferrocene. The bubble kept spontaneously moving on the oil|water interface without applying any force, when it is less than 0.3 mm in diameter. The motion was irregular without decay, suggesting a contribution of Brownian motion. When the three-phase boundary reaction occurred, the bubble motion stopped. It was observed only in the potential domain at which ferrocene is oxidized. The force balance of the air bubble at the O|W interface will be formulated in terms of the interfacial tensions and the buoyancy. It will be demonstrated that the electrode reaction varies the surface tension at the O|W interface to cause surface convection.

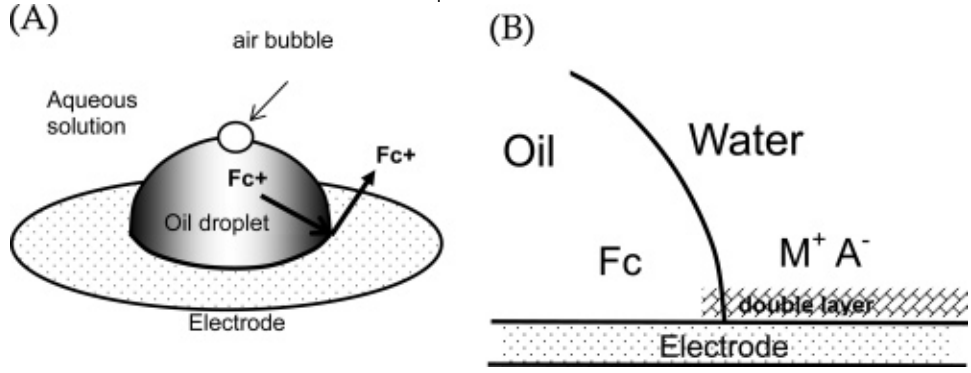

Fig.1. Illustration (A) of a hemispherical oil droplet including an air bubble mounted on an electrode in aqueous solution, and interpretation (B) for the three-phase boundary reaction of ferrocene (Fc) in the oil phase. Supporting ions, M^+ and A^-, form a double layer.

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